Intelligent buffer zones can significantly improve water quality in agricultural catchment areas.

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Literature/Links/ Additional Information

- *www.virkemiddelkatalog.dk*
- *https://www.buffertech.dk*
- *www.goodstream.se*
- *www.wetlands.se*
- Project "CLEARANCE – Circular Economy Approach to River pollution by Agricultural Nutrients with use of Carbon-storing Ecosystems":

Researchers from Warszawa, Aarhus, Berlin, Greifswald and Nijmegen explore the potential of wetland buffer zones for a circular economy, taking into account the role of these zones for water purification, nature conservation, nutrient reuse and agriculture.

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WET BUFFER ZONES

When the buffer zone is set up, a trench running parallel to the steam is created.

Intelligent Buffer Zones – a solution for water and phosphorous retention and nitrogen removal

In many countries the quality of surface and ground water is increasingly deteriorating. A main reason lays in mismanagement of agricultural land use. A solution to this problem can be the implementation of buffer zones. These zones can be characterized as buffer strips along water courses. More precicely they are called Intelligent or Integrated Buffer Zones (IBZ) as they are entirely connected to the field providing protection against runoff from both field surface and from the ground. Although buffer zones occupy a small area, they greatly improve the quality of water in the agricultural watershed due to their filtering effect on nutrients in the underground water and surface water.

- **keywords: Nutrient retention, natural water retention, wet buffer zones, agricultural run-off, drainage, reduction of N and P, eutrophication, biodiversity, biomass production**

Pressures/ Drivers

Agricultural run-off, drainage and infiltration are among the most significant sources of excess nutrients that pollute our waters – groundwater, surface and coastal waters as well as our seas. These sources of pollution are the reason for moderate ecological status (nutrients, barriers) and low biodiversity in stream and floodplain.

Quality elements

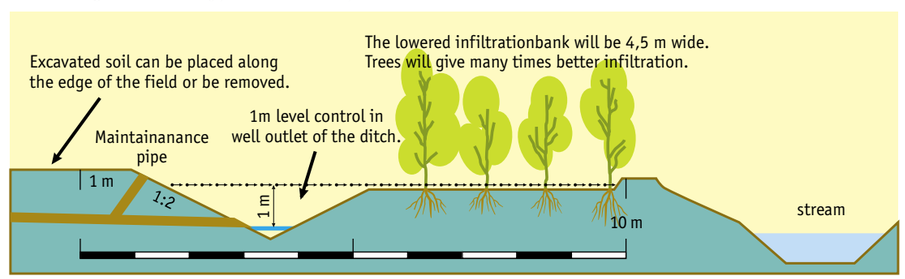
The objective is to contribute to the development of an ecologically efficient and financially sound agricultural production. Agricultural economic growth and increase in productivity can be sustainable and reconciled with environmental goals and directives. The main targets are to minimize losses of nutrients to watercourses, to improve nutrient conditions in the soil and to minimize environmental damage caused by agricultural activities or other usage of land.

MS/region/locality/ location/river basin

Denmark and Sweden; Spjald (western Jutland), Hovvej, Fillerup, Sillerup, Lillerup (eastern Jutland); Vejerslev Mors (North jutland). Lilla Böslid, Bölarp, Sannarp, Reftele, Trönningean, in total around 15 Integrated Buffe Zone Projects (Halland, Sweden).

Motivation – What were the problems?

The reduction of nutrient loads (N and P) is a key task for river basin management in most of the EU Member States, especially in intensively farmed landscapes in the drainage area of the Baltic Sea. Many coastal areas in Europe suffer from high nutrient loads and are heavily eutrophied. The IBZ concept is one of the main tools for achieving the goal of reducing phosphorus concentrations in the river Trönningeån within the framework of the LIFE Project "LIFE-Good Stream". In this area, this new tool is introduced on a large scale along with other types of wetland plants.



Section through a 10 m wide IBZ facility next to the stream.

Trees within the infiltration zone optimize the infiltration capacity of the buffer area.

Relevance for Water Framework Directive (WFD)

Quality standards for N and P vary for different types water bodies (national legislation). WFD quality standard for Nitrate: 50 mg/l (groundwater) and often lower than 25 mg/l nitrate in surface waters. Also P can be a limiting factor for algae growth in lakes and rivers. By effectively reducing N or P the status of an eutrophicated water body can sustainably be improved. The main goals are to establish a good ecological status of an agricultural stream and introduce Integrated Buffer Zones in an holistic approach.

Objectives & measures adopted

Intelligent Buffer Zones (IBZ) target the problems with pipe drainage bypassing buffer strips and thereby shortcutting any water retention and bio-geochemical processes for nutrients. The new concept of IBZs is to cut drain pipes before entering the stream by establishing a closed ditch running parallel to the stream, leading to sedimentation and denitrification as well as reducing peak flows. Adjacent to the ditch a controlled water overflow-zone is established allowing the water to infiltrate a zone with trees between the ditch and the stream. No water is transported by surface flow to the stream. In the infiltration zone trees are established to optimize the infiltration capacity of the buffer area.

Establishing an Intelligent Buffer Zone:

1. Finding the drain pipe and open it before it reaches a stream,
2. Establish an infiltration area,
3. Excavating the open canal and remove soil to level the filterbed,
4. Planting with trees (e.g. alder).

The ratio of the area of an IBZ to the drained agricultural land should be approximately 1:1.000 (0.1 %) to 1:100 (1 %) depending on soil and drain water discharge.

Intelligent Buffer Zone should be established in areas between agricultural lands and water courses and on drained agricultural lands. The IBZ needs to be placed in a way that the slope of the land leads the run-off towards the IBZ.

IBZ can also be applied in fields with very little slope towards the stream. The drainage water is collected in an enclosed open ditch, where even soil eroding from the field surface can be caught. A flat embankment for infiltration is established between the ditch and the stream. When the area is flooded the water begins to infiltrate through the soil profile.

Efficient infiltration will take effect if there are trees on the floodable infiltration bank, so that the water can follow the stems and root systems into the soil. Parts of the nutrients will be immobilized in the soil and another part is taken up by the trees which can be harvested when fully grown. When nearby fields need to be worked at, the water level can temporarily be lowered by a well. When the ditch is completely emptied the accumulated nutrient-rich sediment may be excavated and returned to the field.

The concept of IBZ can also be used at the outlet of a "normal" constructed wetlands with a terrasse with planted trees to increase filtration as an additional retention effect of constructed wetlands.

Actors / Procedure

- SEGES, Anlæg & Miljø, Miljø & Land, Flemming Gertz
- Aarhus University, Institute of Bioscience, Carl Christian Hoffmann
- The Danish Agricultural Agency, Jesper Blaabjerg – Land consolidation and wetland restoration as regional development
- Hushållningssällskapet Hallands, John Strand – Experiences from LIFE-Goodstream

Depending on the season, intelligent buffer zones can reduce up to 90 % of phosphorus and 50 % of nitrogen.

Results/ Assessments

Results from testing facilities in Sweden and Denmark as well as demonstration sites in Sweden and Finland show that up to 90% of the phosphorus and 50% of the nitrogen can be removed by an Intelligent Buffer Zone depending on the time of the year (LIFE GoodStream leafletz on IBZ, 2/2017).

Estimates of average reduction of N and P:

Results from a Danish IBZ have shown promising effects based on measurements over 9 months:

- N retention: 34 %
- P retention: 48 %

Results from IBZ test facility in Spjald, western Jutland:

- Annual TN balance (June 15 to July 16)
- Total N retention per ha and year: 1308-2184 kg
- Total P retention per ha and year: 18.8-29.9 kg

IBZs will also capture most of surface run-off from fields and transported sediment, phosphorus and organic nitrogen – an example is from the IBZ test facility at Spjald, western Jutland (Project BufferTech, presented in the Workshop, Slagelse 2017).

Costs and benefits

The cost of establishing buffer zones will primarily comprise the lost production on the area. The extent of this loss obviously will be determined by the yield potential for the buffer zone as well as the grain prices. In addition to this, on livestock farms there may be added costs related to purchase of animal feed if the demand can no longer be met. Furthermore, buffer zones on some livestock farms may imply that the harmony requirements can no longer be met, which may result in expenses for transporting away animal manure.

Basis per hectare 306 Euro + compensation for the buffer zone 282 Euro (161 Euro permanent pasture) = approx. 588 Euro.

Main benefits lay in an increased biodiversity in watercourses and in buffer zones, the reduction of growth of plants in streams (vegetal invasion) due to shading from tree vegetation along the streams and the reduction and retention of nutrients but also a better surface run-off.

Lessons learned

Well constructed Intelligent Buffer Zones will capture most of the surface runoff from fields and the transported sediment, phosphorous and organic nitrogen, so they can be an efficient solution to mitigate nutrient pollution of streams throughout the year. However, the highest efficiency is observed during summer, with highest seasonal impact for the pond. Field measures also show, that some buffer zones do not have enough effect (the effect of P retention is highly variable, N retention is set too high).

Further research on IBZ is needed: What can be done to further improve their efficiency and their long-term performance?